VIII. ECONOMIC IMPACTS

In this chapter, we present the estimated costs and economic impacts associated with the implementation of the proposed regulation. The estimated capital and recurring costs are presented, as well as an analysis of the cost-effectiveness. The economic impacts associated with the costs of the proposed regulation are presented for private companies, as well as governmental agencies.

Legal Requirements

In this chapter, we will also address certain legal requirements that must be satisfied in analyzing the economic impacts of the proposal.

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with businesses in other states.

In addition, the ARB is required under section 43013(b) of the Health and Safety Code (H&SC) to adopt standards and regulations, consistent with H&SC section 43013(a), for marine vessels to the extent permitted by federal law. Health and Safety Code section 43013(a) authorizes ARB to adopt and implement "motor vehicle emission standards, in-use performance standards, and motor vehicle fuel specifications...which the State board has found to be necessary, cost-effective, and technologically feasible..."

A literal reading of H&SC section 43013(a) would lead one to conclude that the criteria "necessary, cost-effective, and technologically feasible" do not apply to a marine vessel regulation because marine vessels are non-vehicular by definition. See H&SC section 39039. However, because the Legislature placed the authorization to regulate marine vessels in H&SC section 43013(b), we will infer a legislative intent to require ARB to determine that its proposed regulations on marine vessels are "necessary, cost-effective, and technologically feasible."

Also, State agencies are required to estimate the cost or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance (DOF). The estimate shall include any non-discretionary cost or savings to local agencies and the cost or savings in federal funding to the State.

Finally, H&SC section 57005 requires the Air Resources Board to perform an economic impact analysis of submitted alternatives to a proposed regulation before adopting any major regulation. A major regulation is defined as a regulation that will have a potential cost to California business enterprises in an amount exceeding ten million dollars in any single year. The estimated cost of the proposed regulation does exceed ten million dollars in a single year, although much of the cost will be borne by businesses based

outside of California. Nevertheless, we have conducted an economic impact analysis of submitted alternatives to the proposal.

The following is a description of the methodology used to estimate costs as well as ARB staff's analysis of the economic impacts on California businesses and State and local agencies.

A. Summary of the Economic Impacts

Under the proposed regulation, ocean-going vessel (or "vessel") operators can comply through the use of distillate marine fuel or equally effective emission control strategies. This requirement would apply when ships are within 24 nautical miles (nm) of the California coastline.

To estimate the costs of compliance with the proposed regulation, the use of distillate marine fuel will be assumed because the costs can be predicted more accurately compared with the wide range in potential costs from the multitude of potential alternative control strategies. In addition, it is unlikely that alternative control strategies would be pursued unless they are less expensive than the use of distillate marine fuels.

To estimate the costs for 2007 through 2009, we assume that vessel operators will use marine gas oil (MGO) to comply with the proposed regulation. For 2010 and later, we assume that vessel operators will use of 0.1 percent sulfur MGO. However, it should be noted that the 2010 emission limit will be subject to a feasibility evaluation that will consider the supply of this fuel in 2010, as well as technical issues. Therefore, it is possible that this standard could be modified. In addition, throughout the analysis, the costs to passenger cruise vessels (diesel-electric vessels) and cargo vessels (generally direct drive motor-ships) will be analyzed separately due to the differences in these vessel types.

Since the majority of vessels currently use heavy fuel oil in their auxiliary engines, most vessel operators will need to switch to more expensive marine distillate fuel in California upon entering the 24 nm boundary. This fuel is roughly twice as expensive by weight as heavy fuel oil. The added cost to businesses due to the higher cost of using distillate fuel will vary widely based on the amount of heavy fuel oil they use in California. For example, a business that owns a single small cargo vessel that makes a single annual visit to a California port may incur an added cost of a couple thousand dollars, while an operator of a large fleet of vessels that make frequent California port visits may incur costs exceeding a million dollars annually. On average, we estimate the added annual fuel cost for a typical cargo vessel operator at about $20,000 per company ($17,000 for years 2007 to 2009, and $19,000 for 2010 and later). For passenger cruise vessel operators, we estimate the added annual fuel cost at about $2 million per company ($1.7 million for years 2007 to 2009, and $1.9 million for 2010 and later). For the entire oceangoing shipping fleet that visits California, we estimate an added annual fuel cost of about $34 million (2007-2009), and $38 million (2010 and later). These estimates are based on current fuel consumption and do not account for growth.

In addition, we estimate that about five percent of non-diesel-electric (cargo) vessels, and about forty percent of diesel-electric (passenger cruise) vessels will need some modifications such as adding a new fuel tank and piping. These costs will vary widely with the type of modifications, but we estimate the average cost to be on the order of $100,000 per vessel for cargo vessels, and $100,000 to $500,000 for diesel-electric vessels. We estimate the total retrofit cost to the industry at about $11 million to $18 million dollars.

We do not expect significant economic impacts to the industry based on the added costs of the proposed regulation. The added costs of the regulation are relatively minor compared to the overall operating expenses of these vessels. In addition, based on an analysis of the change in "return on owners equity" (ROE) for typical businesses, the added costs of the proposed regulation would result in less than a one percent change in ROE. Generally, a decline of more than ten percent in ROE suggests a significant impact on profitability. Because the proposed regulation would not alter significantly the profitability of most businesses, we do not expect a noticeable change in employment, business creation, elimination, or expansion, and business competitiveness in California. We also do not expect significant economic impacts on governmental agencies on the local, state, or federal level. Military vessels are exempt from the proposed regulation.

We also do not expect significant impacts on the customers served by ocean-going vessel operators, even assuming that all of the added costs are passed on to customers. For example, we estimate that the added cost of the proposed regulation would add about a dollar per container for importers or exporters shipping containerized goods overseas. We estimate that this represents less than one percent of the shipping cost. For passenger cruise ships, we estimate the added cost of the proposed regulation for a typical Los Angeles to Mexico cruise would be about $8 per passenger, representing about a 2 percent fare increase.

The overall cost-effectiveness of the proposed regulation, considering only reductions in diesel PM, is estimated to be about $52,000 per ton of diesel PM reduced ($26 per pound of diesel PM) from 2007 to 2009, and about $53,000 per ton of diesel PM reduced ($27 per pound of diesel PM) in 2010 and later, when the 0.1 percent sulfur marine gas oil limit is scheduled to be implemented. This is similar to the cost-effectiveness of other regulations adopted by the Board to reduce diesel PM. However, the proposed regulation would also reduce emissions of nitrogen oxides (NOx) and sulfur oxides (SOx). Attributing half the cost of the proposed regulation to diesel PM, and half to NOx plus SOx, the cost-effectiveness for 2007 to 2009 would be about $26,000/ton ($13/pound) of diesel PM reduced, and about $3,000/ton ($1.50/pound) of NOx+SOx reduced. For 2010 and later, the cost-effectiveness would be about $27,000/ton ($14/pound) of diesel PM reduced, and about $2,700/ton ($1.40/pound) of NOx+SOx reduced.

The health benefits of implementing the proposed regulation are substantial. The estimated statewide benefit of reduced premature mortality is about $3 billion at a seven percent discount rate, and $4 billion at a three percent discount rate.

B. Capital Costs

In order to use marine distillate fuels in their auxiliary engines, some vessel owners will need to add additional tanks and piping, or make other modifications to their vessels. This will result in capital costs to the vessel owner. To estimate the number of vessels requiring modifications, we conducted the ARB 2005 Ship Survey ("Survey"). The Survey requested that respondents identify whether their vessels will require modifications to use distillate fuel and the nature of the changes if needed. (ARB, 2005). Eleven companies reported 32 vessels that would require modifications out of 358 total vessels reported in the Survey (i.e., less than 10 percent would require retrofits). More specifically, 8 cargo vessel operators reported 15 vessels requiring modifications, and 3 cruise vessel operators reported 17 vessels requiring modifications. The types of retrofits reported by vessel operators included the addition of fuel tanks, segregation of existing fuel tanks for distillate fuels, addition of a mixing tank and fuel treatment equipment, and fuel pump and fuel injector modifications.

Estimated Average Retrofit Cost per Vessel

The average cost to modify a vessel to use distillate fuel is difficult to estimate because the cost will vary widely based on the particular vessel and the type of modifications. One common modification would be the addition of a tank for distillate fuel, or the partitioning of an existing tank. To estimate the potential cost to add a tank, ARB staff reviewed the available literature, contacted marine engineering firms, and requested information from respondents to the Survey. Our findings and recommendations are summarized below.

The U.S. EPA estimated the cost to add a fuel tank and associated piping to allow a vessel to use cleaner fuel (either distillate or 1.5% sulfur heavy fuel oil) at $50,000. (U.S. EPA, 2002). Relatively little information was provided in the U.S. EPA report detailing how the estimate was derived, so marine engineering firms were contacted to estimate the cost of installing an additional tank that would allow a typical cargo vessel to comply with the proposal. They responded that the $50,000 estimate in the U.S. EPA report was reasonable assuming the vessel is in dry-dock for other maintenance (Herbert Engineering, 2005; Sweeney, 2005).

Others have reported higher costs. For example, a report prepared for the European Union estimated the cost to install a tank, as well as pumps, gauges, and ancillary equipment at 25,000 € (~$30,000) for a 30 meter vessel, and 80,000 € (~$96,000) for a 100 meter vessel. (Entec, 2002). However, the vessels mentioned in the report are smaller than those subject to the proposed control, and it is unclear whether or not the fuel tanks would provide capacity only for auxiliary engine use. ARB staff also

contacted respondents to the Survey that indicated that some of their vessels would require retrofits. Only one company responded with an estimate of $350,000 to $500,000 for a passenger cruise vessel. However, as discussed later in this chapter, cruise vessels and other diesel-electric vessels may have higher retrofit costs than other types of vessels. For this reason, a separate business impacts analysis was performed for these vessels, which account for less than three percent of the vessels that visit California annually. Considering the information available and the uncertainty in estimating the retrofit costs, ARB staff proposes to double the U.S. EPA estimate for cargo vessels and use $100,000 per vessel retrofit (except for diesel-electric vessels) to avoid underestimating the cost. For diesel-electric vessels (cruise vessels and some tankers), ARB staff proposes a range from $100,000 to $500,000.

Total Capital Cost of the Proposed Regulation

The capital cost was estimated based on the estimated number of vessels requiring modifications and the cost per vessel. These costs were analyzed separately for non-diesel-electric (cargo) vessels, and diesel-electric (cruise vessels) as shown in Table VIII-1 below.

For cargo vessels, 15 of the 317 cargo vessels reported in the Survey (about 5 percent) were reported to require modifications. According to the California State Lands Commission (CSLC), 1,945 unique vessels (excluding barges) visited California in 2004 (CSLC, 2005). Excluding the 44 cruise vessels from the data, there are about 1,900 cargo vessels. Applying the 5 percent modification rate to the CSLC data (less barges and cruise vessels), we estimate that about 95 cargo vessels would require modifications. Assuming the cost of these retrofits averages $100,000 per vessel, we estimate the total capital cost for cargo vessels would be about $9.5 million.

For cruise vessels, the Survey can be used to directly estimate the number of vessels to be modified because the Survey coverage was nearly complete. Forty-one vessels were reported out of 44 reported by the CSLC data, and 17 of these were indicated to require modifications. Using the 17 vessels and a range in cost from $100,000 (the average for other vessel types) to $500,000 (the highest estimate received as discussed above), the estimated total capital cost to the cruise vessel industry is $1.7 to $8.5 million.

TableVIII-1: Capital Cost Summary

Industry Sector	Estimated Retrofit Cost ($/Vessel)	Estimated Number of Retrofitted Vessels	Total Industry Capital Cost ($/year)
Cargo Vessels	$100,000	95	$9.5 million
Passenger Cruise Vessels	$100,000 to $500,000	17	$1.7 to $8.5 million
Total	N/A	197	$11 to $18 million

There are a number of reasons why the actual capital costs may be different than our estimate. First, the number of vessels requiring retrofits (and the associated total capital costs) may be lower or higher than the above estimate. This is because we modified the proposed regulation after the Survey was conducted to remove the sulfur limit cap on marine gas oil (MGO) for the initial fuel requirement, whereas MGO with a sulfur cap of 0.2% sulfur was the proposed requirement at the time of the Survey. As such, some vessels may not need to add tankage and associated piping to comply with the proposal because they may already carry complying marine distillate fuels.

The current proposal still includes a provision requiring the use of 0.1% sulfur marine gas oil in 2010 subject to a feasibility review. However, this proposal is designed to align with the European Union's Directive which requires the use of 0.1% sulfur MGO for vessels at dockside and in inland waterways. (EU, 2005). It is likely many vessels may already be planning vessel retrofits to meet the EU requirement.

Moreover, the inclusion of a noncompliance fee option to the proposal will also reduce the number of vessels that will need to perform retrofits. Under this option, which was not included in the proposal at the time of the Ship Survey, an infrequent visitor that would otherwise need to perform vessel modifications to use distillate fuel could pay a fee in lieu of compliance with the proposal's fuel requirements.

Another factor that may affect the actual capital costs is the number of new visitors to California ports. As stated above, we based the total capital cost on the estimated total number of vessels that may require modifications to visit California ports in 2004. However, in subsequent years, there will be some new vessels visiting California ports. These could be vessels that did not visit California ports previously, or new vessels that have been added to the worldwide fleet. Some of these vessels may be required to perform modifications to use distillate fuel under the proposed regulation.

The actual number of these new vessels is difficult to estimate due to a variety of variables, including growth in the various shipping sectors, vessel turnover, and route changes initiated by individual businesses due to normal fluctuations in demand. The number of new vessels also could change as vessel owners try to minimize the number of vessels that would require modifications. Nevertheless, to determine an upper end cost estimate, we compared vessel visits over a two-year period. Based on our analysis of State Lands Commission data for 2003 and 2004, we estimate that roughly 50 percent of the vessels in 2004 did not visit in 2003. (CSLC, 2005). Assuming capital costs are proportional to the number vessels, we estimate the capital costs at about half the initial year total capital cost of $11 to $18 million, or $5.5 to $9 million annually, increasing the total present value cost of the regulation from $165 to $171 million, to $184 to $200 million (over a five year lifetime). Under this scenario, the 2007-2009 cost-effectiveness for PM would increase from about $52,000 per ton PM reduced, to $58,000 - $63,000 per ton PM reduced (see Appendix J-Part II).

C. Recurring Costs

The recurring costs associated with the purchase of distillate fuel were determined and accounted for in the cost analysis. We calculated the recurring costs based on the current estimated fuel consumption and the price differential between existing fuels and the cleaner fuels required by the proposal for the years 2007-2011. For years 2007-2009, we calculated the cost based on the consumption of heavy fuel oil in auxiliary engines and the differential in price between the most widely used type of heavy fuel oil (HFO-380) and standard marine gas oil (MGO). For 2010 and 2011, we based the cost on the sum of: (1) the estimated current consumption of heavy fuel oil and the differential in price between HFO-380 and MGO with a 0.1 percent sulfur cap; and (2) the estimated current consumption of standard MGO and the differential in price between standard MGO, and MGO with a 0.1% sulfur cap. Growth in the industry was not projected for this analysis, nor did we attempt to factor in expected price increases due to inflation, given the highly volatile and unpredictable nature of petroleum prices. However, we believe that growth and inflation are likely to have similar effects on both fuels, such that the differential will remain relatively constant. Our assumptions for fuel consumption rates and the price differential between MGO and HFO-380 are described below.

Fuel Consumption Estimates

As shown in detail in Appendix B, we estimated fuel consumption within the 24 nautical mile boundary based on: (1) the estimated NOx emissions from auxiliary engines operating within this zone; (2) the energy specific NOx emission factor for medium speed four-stroke auxiliary engines using heavy fuel oil (Entec, 2002), which allowed emissions to be converted to associated energy in kilowatt-hours; and (3) the brake specific fuel consumption for these engines (*Ibid*), which allowed energy to be converted to estimated fuel consumption. Based on this information, we estimate that about 172,000 metric tons of fuel is currently consumed by auxiliary engines statewide within the 24 nm boundary.

Based on the Survey, we estimate about 92 percent of the fuel used by diesel-electric engines, and 72 percent of the fuel used by auxiliary engines on all other vessels was heavy fuel oil. Overall, about 78 percent of the fuel (by weight) used by all auxiliary engines was heavy fuel oil, and the remaining 22 percent was distillate fuel. Applying this breakdown to the total fuel consumption of 172,000 metric tons, we estimate that about 134,000 metric tons of heavy fuel oil and 38,000 metric tons of distillate fuel are used by the vessels traveling within 24 nm of California's coastline.

Price Premium for Cleaner Fuels

To determine the estimated price differential between heavy fuel oil and distillate fuels complying with the proposed regulation, we estimated an average cost differential using current prices for HFO-380, the most common grade of heavy fuel oil, and marine gas oil. (Bunkerworld, 2005). As shown in Table VIII-2 below, prices were averaged over

the time period from March, 2005 through September, 2005 using three major bunkering ports: Singapore, Rotterdam, and Fujairah. Fuel prices tend to be volatile and may change significantly in the future. However, we believe that the price differential between HFO and MGO will be fairly constant.

Table VIII-2: Marine Fuel Prices ($/tonne)*

Fuel	Fujairah	Singapore	Rotterdam	Average
MGO	512	504	523	513
HFO-380	261	264	243	256
Difference	251	240	280	257

* Bunkerworld, 2005. Prices averaged from March to September, 2005. A "tonne" equals a metric ton, or 2200 pounds.

To determine the cost differential between standard marine gas oil and 0.1 percent marine gas oil, we used a report prepared for the European Union. The report estimated the price premium for 0.1 percent sulfur marine gas oil compared to standard marine gas oil with no sulfur limit at 14-21 €/metric ton, or about $21/metric ton using the median cost from the range and a conversion of 0.83 Euro per dollar. (Beicip-Franlab, 2002). Table VIII-3 summarizes the estimated price differential for the cleaner fuels specified in the proposed regulation.

Table VIII-3: Fuel Price Differential Due to Proposed Regulation

Year	Fuel Change	Price Premium* ($/tonne)
2007-2009	HFO-380 to Standard MGO	257
2010 and later	HFO-380 to 0.1% S MGO	278
2010 and later	Standard MGO to 0.1% S MGO	21

*Reflects data from Table VIII-2 above and "Advice on the Costs to Fuel Producers and Price Premium Likely to Result from a Reduction in the Level of Sulphur in Marine Fuels Marketed in the EU," Beicip-Franlab, April 2002. A "tonne" equals a metric ton, or 2200 **pounds.**

Total Recurring Costs

The total annual recurring costs for years 2007-2009, and 2010 and later, for each industry sector and for the total marine industry are shown below in Tables VIII-4 and VIII-5. These estimates are based on the estimated fuel consumption by sector and price differentials shown in Table VIII-3 above.

Table VIII-4: Total Industry Annual Fuel Costs for Years 2007-2009

Marine Industry Sector	Estimated HFO Consumed (tonne)*	Price Differential ($ per tonne)	Total Sector Cost (millions)
Auto Carrier	3,500	$257	$0.90
Bulk	14,000	$257	$3.60
Container	58,000	$257	$14.9
General	6,000	$257	$1.50
Passenger	40,000	$257	$10.3
Reefer	2,200	$257	$0.60
RORO	1,300	$257	$0.30
Tanker	9,000	$257	$2.3
Total	134,000	$257	~$34

* Estimated annual fuel consumption based on methodology used above for total industry fuel consumption.

The total annual recurring fuel cost estimates for 2010 and later reflect the use of somewhat higher cost 0.1 percent sulfur marine gas oil, as shown in Table VIII-5 below. Specifically, the current estimated fuel consumption of heavy fuel oil is multiplied by the higher incremental cost ($278) between heavy fuel oil and 0.1 percent sulfur marine gas oil. The current estimated fuel consumption of marine distillate fuels is multiplied by the higher incremental cost ($21) between standard marine gas oil and 0.1 percent marine gas oil. These costs were added to obtain the total recurring fuel cost by industry sector.

We do not expect significant additional recurring costs to the industry due to recordkeeping and reporting requirements, crew time, or other factors, which are discussed in section E of this Chapter.

Table VIII-5: Total Industry Annual Fuel Costs for 2010 and Later

Marine Industry Sector	Estimated HFO Consumed (tonne)*	Estimated MGO Consumed (tonne)*	Price Differential (HFO to 0.1% S MGO)	Price Differential (Std. MGO to 0.1% S MGO)	Total Sector Cost (millions)
Auto Carrier	3,500	1,100	$278	$21	$1.0
Bulk	14,000	5,300	$278	$21	$4.0
Container	58,000	22,600	$278	$21	$16.6
General	6,000	2,300	$278	$21	$1.7
Passenger	40,000	2,600	$278	$21	$11.2
Reefer	2,200	850	$278	$21	$0.63
RORO	1,300	500	$278	$21	$0.37
Tanker	9,000	3,200	$278	$21	$2.6
Total	134,000	~38,000	$278	$21	~$38

* Estimated fuel consumption based on methodology used above for total industry fuel consumption.

D. Total Industry Cost and Total Annual Cost

Total Industry Cost

We estimate the total statewide cost of the proposed regulation over a 5 year period to be about $165-171 million dollars. This estimated cost was derived from the present value of the capital costs shown in Table VIII-1 combined with the present value of the recurring costs shown in Tables VIII-4 and VIII-5, over a 5 year period (see Appendix B).

Total Annual Cost

The total annual cost, including the total capital costs from Table VIII-1, and the recurring costs from Tables VIII-4 and VIII-5, is estimated to be about $38 million for years 2007-2009, and about $42 million for 2010 and 2011 (See Appendix B). The majority of the estimated total annual cost is contributed by the recurring fuel costs.

E. Potential Additional Costs or Savings

There may be some other costs and potential cost savings that could be incurred under the proposed regulation, but data were not available to enable quantification of these possible impacts. Nevertheless, the net impact of these costs and savings is not expected to be significant. These are briefly described below.

Distillate fuel may result in lower or higher maintenance costs

Marine distillate fuel has a lower sulfur and ash content than heavy fuel oil and may result in a permanent, ongoing reduction in engine maintenance in some engines due to

a reduction in deposit formation (Croner, 2002). On the other hand, the use of lower viscosity distillate fuel may make leaks at weak pipe joints more likely than the use of heavier fuels, requiring additional maintenance. Because these effects, to the extent they may occur, are very engine and vessel-specific, we cannot quantify the overall potential savings or added costs from changes in maintenance costs.

Crew time/training

The fuel switching operations necessary under the proposed regulation may be automated or performed manually, depending on the specific vessel. Depending on the fuel system, training of the vessel crew may be required. Vessel crew time would also be required to perform the fuel transition upon entering and leaving the 24 nautical mile boundary. Because of the uncertainty in the extent additional crew time and training may be needed, we are not able to estimate these costs. However, to the extent crew training is required, we expect such crew training to be minimal because vessels must already switch to marine gas oil prior to dry dock maintenance, and fuel transitions may be handled with the existing crews.

Dry-dock costs

The proposed regulation provides up to a one year extension for a small minority of vessels requiring significant modifications to comply with the proposed regulation (i.e., a fraction of the 10 percent of vessels requiring some modification). In addition, a noncompliance fee provision provides an option that allows vessel operators to pay a fee in lieu of compliance for up to five port visits per vessel, if their vessel requires modifications to comply with the proposal. However, even with these provisions, there may still be a small number of vessels that need to make modifications in response to the proposed regulation prior to a regularly scheduled dry-dock date. This would result in lost business opportunities while the vessel is out of service for modifications. We are not able to predict the extent this would occur and therefore cannot accurately quantify these costs.

Fueling costs

Some manufacturers have reported that the proposed regulation may result in more frequent fueling because they may use a smaller tank for the more expensive fuel that can be used to comply with the proposed regulation. However, we cannot predict the extent to which this would occur and the industry has not supplied estimates of these costs.

Loss of Cargo Capacity

For the minority of vessels that will need to add a fuel tank to comply with the proposed regulation, there is a possibility that the addition of the tank will reduce the cargo carrying capacity of the vessel. However, vessel owners can in many cases opt to

segregate a volume of an existing tank to avoid this impact. We are unable to estimate the extent of these potential impacts.

Recordkeeping

We do not expect significant added costs to the industry due to the recordkeeping and reporting requirements in the proposed regulation. The proposed regulation would require records be kept of: (1) the date, time, and position of the vessel upon entry to and exit from the 24 nm boundary, and upon initiation and completion of fuel transitions; and (2) fuel purchases, and the types of fuels used within the 24 nm boundary. The recording of fuel purchases and fuel use is already required in accordance with standard practices as well as other regulations and Vessel Classification Society requirements. Recording the date, time, and position of the vessel as required by the proposed regulation would be an added requirement, but we do not expect these activities to require significant time or costs to comply as these can easily be logged either manually or automatically. We expect that existing vessel crews can readily record these data. Finally, the proposed regulation does not require periodic reporting of records. Reporting is only required upon request.

F. Estimated Cost to Businesses

The proposed regulation would primarily impact businesses that operate large ocean-going vessels. These costs are estimated below for typical (average) businesses. However, the cost to individual businesses will vary widely based on factors such as the following:

- number of vessels visiting California ports;
- number of California port visits per vessel;
- power generated, and thus fuel consumed, by the auxiliary engines;
- whether the vessel is a "diesel-electric" vessel; and
- number of vessels requiring retrofits.

For example, a business that owns a single small cargo vessel that makes a single annual visit to a California port visit may incur an added fuel cost of a couple thousand dollars. On the other hand, a large vessel operator with several vessels making frequent California port visits may incur added fuel costs approaching a million dollars annually.

Table VIII-6 below provides a summary of the range of added fuel costs that could be incurred by shipping companies. As shown, most companies make relatively few visits and would incur proportionally lower costs, while a small number of large operators would incur costs up to about $1 million. The average added fuel costs for travel in the 24 nm boundary associated with a California port visit ($3,400/visit) was approximated by dividing the total annual industry recurring cost for years 2007 to 2009, $34 million dollars (see Table VIII-4), by the roughly 10,000 port visits to California ports. In

addition, as described below, operators of diesel-electric vessels such as passenger cruise vessels are expected to incur greater costs.

Table VIII-6: Estimated Average Added Fuel Cost to Vessel Operators*

Number of Companies	Number of California Port Visits	Added Fuel Cost @$3,400 per Visit
3	200-300	$680,000-$1 million
6	100-199	$340,000-$677,600
20	50-99	$170,000-$336,600
210	10-49	$34,000-$166,600
221	5-9	$17,000 - $30,600
83	4	$13,600
124	3	$10,200
265	2	$6,800
500	1	$3,400
1432 Total	~10,000 Total	N/A

* Company and port visit information based on the California State Lands Commission data. Added costs assume no diesel-electric vessels, which represent less than 3% of the fleet visiting California.

We do not believe that the vessel operators subject to this proposed vessel would qualify as small businesses due to the large capital and operating costs associated with vessel operation. Typical container vessels are estimated to cost on the order of $50 to $100 million (Mercator, 2005). In addition, Government Code section 11342.610 excludes businesses in transportation and warehousing with annual gross receipts exceeding one and a half million dollars from its definition of "small business." We believe that the annual gross receipts for a profitable vessel owner or operator would far exceed this level in order to be profitable. For example, a single Asia to U.S. West Coast voyage for a typical container vessel costs about $2 to $3 million. (*Ibid*) Therefore, we do not believe there are any small businesses directly affected by the proposed regulation. As such, we have only included costs in this analysis for typical businesses.

The capital and recurring costs to typical businesses are discussed below. Separate analyses are performed for operators of non-diesel-electric vessels (mainly cargo vessels) and diesel-electric vessels (passenger cruise vessels and some tankers), which are expected to incur greater costs. Diesel-electric vessels make up less than three percent of the fleet that visits California.

Capital Costs to Typical Businesses (except diesel-electric vessels)

As discussed previously, capital costs due to the proposed regulation would include vessel modifications, such as adding fuel tanks and piping, or engine modifications. These costs are vessel-specific and are expected to vary widely, with most vessels requiring no retrofits and a few incurring significant costs. According to ARB's Survey,

only about 5 percent of non-diesel-electric (cargo) vessels are expected to require modifications. For those companies with vessels that require modifications, the Survey reported a range of one to four vessels requiring modifications per company. Overall, 8 companies reported a total of 15 vessels requiring modifications, or an average of roughly 2 per company. Based on an estimated cost of $100,000 per vessel (section B above), the total cost for a typical company with vessels requiring modifications would be about $200,000, with a range from $100,000 to $400,000.

Recurring Costs to Typical Businesses (Except Diesel Electric Vessels)

The recurring cost for typical businesses is based on the ongoing higher cost of marine distillate fuels that would be required by the proposed regulation. The total cost to a particular company will vary directly with the amount of fuel consumed by the company's vessels operated in California. To determine the average annual ongoing cost for a typical business, we divided the total estimated fuel cost of the regulation for non-diesel-electric vessels by the number of shipping companies that operated ocean-going vessels in California in 2004, as reported by the California State Lands Commission. Specifically, we divided the total recurring cost of $24 million for years 2006-2009 as shown in Table VIII-4 (excludes diesel-electric cruise vessels), and $27 million in 2010 and subsequent years as shown in Table VIII-5, by the approximately 1,400 companies reported by the California State Lands Commission to be responsible for vessel visits to California. (SLC, *supra*) This resulted in an average added fuel cost per company of about $17,000 per year (2006-2009) and $19,000 per year (2010 and later).

Summary of Costs to Typical Businesses (except passenger cruise vessels)

Table VIII-7 below summarizes the costs to a typical business with and without vessels requiring retrofits. As noted previously, only about 5 percent of non-diesel-electric vessels are expected to require modifications, so the cost to most affected businesses would be represented by the recurring higher cost of fuel only. The capital costs are annualized over a five year period, after which only the recurring costs would remain.

Table VIII-7: Summary of Costs to Typical Businesses

Affected Business	Capital Cost	Annualized Capital Cost*	Recurring Cost	Total Annual Cost
Modifications on 2 vessels	$200,000	$46,200	$17,000 - $19,000 (2010)	$63,200 - $65,200 (2010)
No Modifications	0	0	$17,000 - $19,000 (2010)	$17,000 - $19,000 (2010)

*Capital costs annualized over 5 years, 5% interest rate. Recurring cost based on use of marine gas oil meeting ISO sulfur standards (pre 2010).

Costs to Businesses Operating Diesel-Electric Vessels

In this section, we analyze the costs to businesses operating diesel-electric vessels. These businesses are analyzed separately because we expect the proposed regulation to result in greater impacts on diesel-electric vessels, compared to other types of vessels.

The cost impacts of the proposed regulation are greater for diesel-electric vessels because the large diesel generator sets on these vessels are used for both propulsion and ship-board electricity. Therefore, the amount of fuel used by these engines is greater than for auxiliary engines on other types of vessels, and the cost impacts are larger by a commensurate amount.

To determine the impacts on diesel-electric vessels, we focused solely on passenger cruise vessels. Based on the Survey, all passenger cruise vessels serving California were reported to be diesel-electric. With the exception of a couple of tankers that are diesel-electric (but exempt from the proposed regulation because they use slow-speed two-stroke engines), the Survey results did not report any other diesel-electric vessels. However, ARB staff is aware of at least one diesel-electric tanker that recently entered into California that uses an engine that would be subject to the proposed regulation. (Seafarers, 2005)

To put the cost impacts of diesel-electric vessels into perspective, we estimated the average fuel cost associated with a single port visit. To estimate this cost, we divided the total estimated added cost to the cruise vessel industry, $10.3 million (2007-2009), by the 687 port calls to California per the CSLC, yielding about $15,000 per port visit, compared with about $3,400 per port visit for non-diesel-electric vessels as discussed above.

To determine the recurring fuel cost on a typical cruise vessel business, we divided the total estimated added fuel cost of $10.3 million (2007-2009) to $11.2 million (2010 and later) annually by the six companies that reported to the survey. This resulted in an added annual fuel cost of nearly $2 million per company ($1.7 for 2007-2009, and $1.9 million per company for 2010 and later). However, it should be noted that this cost is relatively high compared to businesses operating other types of vessels because cruise vessels make more trips to California ports on average than other types of vessels, and because the passenger cruise industry has undergone mergers in the last few years that have consolidated more vessels under fewer companies.

In addition to higher fuel costs, it appears that these vessels are more likely to require modifications. According to the Survey, 17 of the 41 cruise vessels were reported to require vessel modifications. We also note that the California State Lands Commission reported 44 passenger cruise ships visiting California in 2004. (SLC, *supra*) Therefore, the industry participation in the Survey was nearly complete and the cost of modifying the 17 vessels reported should be a fairly accurate indication of the overall cruise vessel industry cost.

For those cruise vessel operators with vessels that require modifications, the Ship Survey reported a range of 1 to 12 vessels requiring modifications per company. Specifically, 3 companies reported a total of 17 vessels requiring modifications, or an average of roughly 6 vessels per company. Based on an estimated retrofit cost of $100,000 per vessel, the total capital cost for a typical company with 6 vessels requiring modifications would be about $600,000, or about $140,000 annualized over 5 years using a 5 percent discount rate. However, there is a possibility that the average cost of modifications per vessel is higher for cruise vessels than for other types of vessels. This is due to the greater amounts of distillate fuels that would be needed to comply with the proposed regulation, and associated fuel tank capacity, piping, and fuel processing equipment. Only one diesel-electric vessel operator (a cruise vessel operator) provided an estimate of the cost of modifying a vessel to comply with the proposed regulation. This estimate, at $350,000 to $500,000 per cruise vessel, was higher than the other sources of information cited previously. Nevertheless, based on the $500,000 figure as an upper bound, the estimated cost to a typical company with 6 vessels requiring retrofits would be about $3 million, or about $700,000 annualized over five years with a 5 percent discount rate.

Table VIII-8 provides a summary of the estimated costs to the cruise vessel industry. As mentioned previously, about 17 of the 41 cruise vessels reported in the Ship Survey were reported to require retrofits. However, the annual cost of fuel is much higher than the annualized retrofit costs, even when using the upper end retrofit cost estimate of $500,000 per vessel.

Table VIII-8: Summary of Costs* to Typical Cruise Vessel Business

Affected Business	Capital Cost	Annualized Capital Cost*	Recurring Cost	Total Annual Cost
Retrofits on 6 vessels	$600,000 to $3.0 million	$140,000 to $700,000	$1.7-1.9 million	$1.8-2.6 million
No Retrofits	0	0	$1.7-1.9 million	$1.7-1.9 million

*Capital costs annualized over 5 years at a 5% discount rate. Recurring cost based on the use of marine gas oil meeting ISO sulfur standards (pre 2010).

G. Potential Business Impacts

In this section, we analyze the potential impacts of the estimated costs of the proposed regulation on business enterprises. Section 11346.3 of the Government Code requires that, in proposing to adopt or amend any administrative regulation, State agencies shall assess the potential for adverse economic impact on California business enterprises and individuals. The assessment shall include a consideration of the impact of the proposed or amended regulation on the ability of California businesses to compete with businesses in other states, the impact on California jobs, and the impact on California business expansion, elimination, or creation.

This analysis is based on a comparison of the annual return on owner's equity (ROE) for affected businesses before and after the inclusion of the capital and recurring costs associated with the proposed regulation. The analysis also compares the estimated added costs of the proposed regulation to the overall operating costs of these vessels

ARB staff does not have access to financial records for many of these companies. However, it should be noted that many of these businesses are not California-based businesses. Many are foreign owned enterprises, sometimes involving complicated ownership arrangements involving consortiums of investors.

As stated in Section E above, we do not believe that the businesses subject to this proposed regulation would qualify as small businesses due to the large capital and operating costs associated with vessel operation.

Analysis of Return on Owner's Equity (ROE)

In this section, we evaluate the potential economic impact of the proposed regulation on California businesses as follows:

(1) Typical businesses affected by the proposed regulation are identified from port visit data from the California State Lands Commission. The Standard Industrial Classification (SIC) codes associated with these businesses are listed in Table VIII-9 below;

(2) The annual costs of the proposed regulation are estimated for each of these businesses based on the SIC code. For ranges in cost estimates, the high end of the range was used;

(3) The total annual cost for each business is adjusted for both federal and state taxes; and

(4) The adjusted costs are subtracted from net profit data and the results used to calculate the ROE. The resulting ROE is then compared with the ROE before the subtraction of the adjusted costs to determine the impact on the profitability of the businesses. A reduction of more than 10 percent in profitability is considered to indicate a potential for significant adverse economic impacts. This threshold is consistent with the thresholds used by the U.S. EPA and others.

Using publicly available financial data from 2002 to 2004 for the representative businesses, staff calculated the ROEs, both before and after the subtraction of the adjusted annual costs, for the typical businesses from each industry category. These calculations were based on the following assumptions:

(1) All affected businesses are subject to federal and state tax rates of 35 percent and 9.3 percent, respectively; and

(2) Affected businesses neither increase the cost to their customers, nor lower their cost of doing business through cost-cutting measures due to the proposed regulation.

These assumptions, though reasonable, might not be applicable to all affected businesses.

The results of the analysis are shown in Table VIII-9 below. Using the ROE to measure profitability, we found that the ROE range for typical businesses from all industry categories would have declined by less than one percent due to the proposed regulation. This represents a small decline in the average profitability of the affected businesses. Overall, most affected businesses will be able to absorb the costs of the proposed regulation with no significant impacts on their profitability.

Table VIII-9: ROE Analysis of Businesses

SIC Code	Description of SIC Code	Percent Change in ROE
4412	Deep Sea Foreign Transportation of Freight	-0.01
4424	Deep Sea Domestic Transportation of Freight	-0.05
4481	Deep Sea Passenger Transportation	-0.60

Comparison of the Costs of the Proposed Regulation with Vessel Operating Costs

This analysis compares the added costs of the proposed regulation with the normal operating costs of large ocean-going vessels. While the costs of the proposed regulation are substantial, they are a small fraction of the overall operating costs for these businesses. For example, based on a typical scenario, a container vessel would pay an extra $5,000 for fuel during visits to two California ports (see Appendix J-Part IV). We do not expect this cost to have a significant impact on vessel operators, or businesses that rely on the goods transported by these businesses, because the added fuel cost represents a minor percentage of the overall transportation cost. To put this in perspective, the total operating cost of a single Asia to U.S. West Coast voyage for a typical container vessel is estimated to be about 2 to 3 million dollars. Therefore, the $5,000 added cost represents less than one percent of the total transportation cost for the voyage, or about a dollar per shipping container for a 5,000 TEU (transport equivalent unit) vessel, out of total costs on the order of $500 per TEU. (Mercator, *supra*)

As compared to typical cargo vessels, the proposed regulation will have a larger impact on diesel electric-vessels (primarily cruise lines and some tankers). Nevertheless, we do not think the added costs will significantly impact these vessel operators. The added cost of the proposal for a typical cruise vessel visit to Mexico from the Los Angeles area would be about $16,000 (see Appendix J-Part III). Because a typical cruise vessel for this voyage carries about 2,000 passengers (Carnival, 2005a), the added cost would be

about $8 per passenger. For a relatively low cost 3 or 4 day Mexico cruise, about $350 (Carnival, 2005b), a 2 percent increase in fare would be needed to offset the increased fuel cost.

Because the added costs of the proposed regulation are such as small percentage of the overall operating costs for both cargo and cruise vessels, we do not expect a significant impact on these businesses. There is also a possibility the proposed regulation will result in a positive impact on business creation due to additional sales of marine fuels in California beginning in 2010, when the 0.1 percent sulfur fuel requirement becomes effective (subject to a feasibility review). This is because California is expected to have 0.1 percent sulfur fuel available, whereas it is uncertain whether other ports worldwide will have this fuel available.

H. Potential Impact on Business Competitiveness

The proposed regulation could potentially affect the ability of California ports and California based vessel operators to compete with ports and vessel operators outside California due to the slight increase in operating costs. However, we do not believe that the added costs of the proposed regulation are high enough for vessel operators to consider alternative ports outside California.

There are several reasons for this. First, many vessel operators utilize California ports because there is already a local market for their goods within California, or because California exporters choose to utilize California ports to vessel their goods overseas. Second, other vessel operators find that the overall cost of transporting goods to their final destination beyond California is lowest by using California ports because of the ports' existing and well established infrastructure, including road and rail access. Third, in some cases, vessel operators would have to factor in the added costs of fuel and other costs of traveling greater distances to non-California ports, which may negate the cost savings in not purchasing the lower sulfur fuel. Finally, as stated previously, the added costs resulting from the proposed regulation are a small fraction of the overall operating costs of these vessels, and these costs are not expected to result in a significant adverse impact on the profitability of typical companies.

Most of the affected businesses that operate vessels are large businesses and can either absorb or pass-through the increased costs associated with the proposed regulation with no significant impact on their ability to compete with non-California businesses. Based on these reasons, we do not believe the relatively low costs of this proposed regulation are high enough to significantly affect the competitiveness of those businesses that are integrally linked to the movement of goods through California ports.

I. Potential Impact on Employment, Business Creation, Elimination or Expansion

The proposed regulation is not expected to have a noticeable impact on employment, or business creation, elimination, or expansion. As stated above, the added costs of the

proposed regulation are a small percentage of the overall operating costs for both cargo and cruise vessels. In addition, an analysis of the impact of the proposed regulation on the profitability of typical businesses indicated no significant adverse impacts.

There is also a possibility the proposed regulation will result in a positive impact on business creation due to additional sales of marine fuels in California beginning in 2010, when the 0.1 percent sulfur fuel requirement becomes effective (subject to a feasibility review). This is because California is expected to have 0.1 percent sulfur fuel available, whereas it is uncertain whether other ports worldwide will have this fuel available.

J. Potential Costs to Local, State, and Federal Agencies

Local Agencies

We do not expect any significant fiscal impacts on local agencies. We are not aware of any local government agency that operates an ocean-going vessel as defined in the proposed regulation. However, some minor impacts are possible on ports, which in California are established by state government and are operated by entities such as port authorities and departments of municipal governments.

The proposed regulation will increase costs for vessels visiting California ports. As such, some vessel operators could potentially choose to utilize alternative ports outside of California. However, as discussed in detail in section G above, we do not believe that this will occur to any significant degree.

We do not expect significant fiscal impacts on local air pollution control agencies due to the proposed regulation because ARB intends to enforce the provisions of the proposal statewide.

State Agencies

We do not expect any significant fiscal impacts on State agencies. The ARB will need to expend resources to enforce the proposed regulation. However, these enforcement activities can be conducted with existing resources in the short term. Eventually, additional resources will be needed as the implementation of this and other port-related measures occur.

The only other State agency identified by ARB staff that could potentially be impacted is the California Maritime Academy (CMA) in Vallejo. The CMA operates the "Golden Bear" training vessel on an annual overseas voyage. This vessel already uses only distillate marine fuel, so it probably already complies with the proposed regulation. However, when the 0.1 percent sulfur marine gas oil requirement becomes effective in 2010 (subject the required feasibility review), there may be an added cost to operate the vessel.

Federal Agencies

We are not aware of any impacts on federal agencies. Military vessels are exempted from the requirements of the proposed regulation.

K. Cost-Effectiveness

For the purposes of this section, cost-effectiveness is defined as the ratio of the cost of compliance per ton of pollution reduced. Cost-effectiveness figures allow different regulations to be compared to determine the most economic way to reduce a given amount of emissions.

In this section, we calculate the cost-effectiveness in two ways. First, we attribute the total annual cost of the proposed regulation to each pollutant individually. This results in the highest cost-effectiveness values, and may overestimate the overall cost-effectiveness of the proposed regulation. For example, a regulation that resulted in the same costs and diesel PM emission reductions, but no reductions in other pollutants, would have the same cost-effectiveness in terms of diesel PM as the proposed regulation. Therefore, as an alternative, we also calculate the cost-effectiveness by attributing half of the costs of the proposed regulation to diesel PM reductions, and the other half to reductions in nitrogen oxides (NOx) and sulfur oxides (SOx).

We also discuss the cost-effectiveness for diesel-electric vessels, which will generally incur greater costs. Finally, we will analyze the cost-effectiveness of some alternative proposals to the proposed regulation recommended by ARB staff.

Cost-Effectiveness of the Proposed Regulation for All Vessels: Attributes All Costs to Each Pollutant Individually

The estimate of the cost-effectiveness of the proposed regulation for all vessels is shown in Table VIII-10 below, expressed in 2005 dollars. The cost-effectiveness is expressed in terms of dollars per ton of NOx, diesel PM, and SOx removed, with the total annual cost attributed to each pollutant individually.

The cost-effectiveness estimates for 2010 and later assumes that the 0.1 percent sulfur marine gas oil requirement becomes effective in 2010. However, this requirement will be subject to the results of a feasibility analysis as required by the proposed regulation that will analyze the available supply of this fuel, cost, and technical feasibility.

Table VIII-10: Cost-Effectiveness of the Proposed Regulation for All Vessels: Attributes All Costs to Each Pollutant Individually

Year	Total Annual Cost ($ millions)	Emission Reductions* (tons per year)			Cost-Effectiveness $/ton and ($/pound)		
		NOx	PM	SOx	NOx	PM	SOx
2007-2009	38	575	730	5,800	66,000 ($33)	52,000 ($26)	6,600 ($3.20)
2010 - 2011	42	575	800	7,200	73,000 ($37)	53,000 ($27)	5,800 ($2.90)

* The emission reductions and costs shown are based on the 2004 emissions inventory to be consistent with other 2004 data used. The emission reductions in 2007 and 2010 will be greater than the emission reduction figures shown.

The cost-effectiveness of the proposed regulation for diesel PM (as calculated in Table VIII-10) is similar to other regulations recently adopted by the Board (see Table VIII-11 below). For example, the diesel PM cost-effectiveness of the solid waste collection vehicle rule was estimated at $56,000 per ton, excluding the benefits of NOx and hydrocarbon reductions. (ARB, 2003a) The cost-effectiveness of the stationary diesel engine airborne toxic control measure (ATCM) was estimated to range from $8,000 to $51,000 per ton of diesel PM reduced. (ARB,2003b) Finally, the transport refrigeration unit ATCM was estimated to have a cost-effectiveness of $20,000 to $40,000 per ton of diesel PM reduced. (ARB, 2003c)

Table VIII-11: Diesel PM Cost-Effectiveness of the Proposal and Other Regulations/Measures (Attributes All Costs to Each Pollutant Individually)

Regulation or Airborne Toxic Control Measure	Diesel PM Cost-Effectiveness	
	Dollars/Ton PM	Dollars/ Pound PM
Ship Auxiliary Engine Proposal	$52,000 - $53,000	$26 – 27
Solid Waste Collection Vehicle Rule	$56,000	$28
Stationary Diesel Engine ATCM	$8,000 - $51,000	$4 - $26
Transport Refrigeration Unit ATCM	$20,000 - $40,000	$10 - $20

Cost-Effectiveness of the Proposed Regulation for All Vessels: Attributes Half the Costs to Diesel PM and Half to NOx plus SOx

In Table VIII-12 below, we calculate the cost-effectiveness by attributing half of the costs of the proposed regulation to diesel PM reductions, and the other half to reductions in nitrogen oxides (NOx) and sulfur oxides (SOx). This may reflect the overall cost-effectiveness more accurately in that it accounts for the multiple benefits of the proposed regulation.

Table VIII-12: Cost-Effectiveness of the Proposed Regulation for All Vessels: Attributes Half of the Costs to Diesel PM and Half to NOx+SOx

Year	Half of Total Annual Cost ($ millions)	Emission Reductions (tons per year)		Cost-Effectiveness $/ton and ($/pound)	
		PM	NOx+SOx	PM	NOx+SOx
2007-2009	19	730	6,300	$26,000 ($13.00)	$3,000 ($1.50)
2010 - 2011	21	800	7,800	$27,000 ($14.00)	$2,700 ($1.40)

Cost-Effectiveness for Diesel-Electric Vessels

As explained in section F, the costs of the proposed regulation are greater for diesel-electric vessels because the large diesel generator sets these vessels use for both propulsion and ship-board electrical uses are covered as "auxiliary engines" under the proposed regulation. However, the emission reductions resulting from the use of distillate fuels will increase proportionally with the cost, so the overall cost-effectiveness of the proposed regulation for these vessels is similar to the other types of vessels. This is shown by comparing the cost-effectiveness results of Table VIII-10, for all vessels, to the results in Table VIII-13 below for diesel-electric vessels only. Similarly, the cost-effectiveness for diesel electric vessels would also be comparable to all vessels using the alternative calculation where half of the proposed regulation costs are attributed to diesel PM and half to NOx plus SOx (as calculated in Table VIII-12).

Table VIII-13: Cost-Effectiveness of Proposal on Diesel-Electric Vessels

Year	Total Annual Cost ($ millions)	Emission Reductions (tons per year)			Cost-Effectiveness $/ton and ($/pound)		
		NOx	PM	SOx	NOx	PM	SOx
2006-2009	10.7 to 12.3	150	215	1,700	$71,000-$82,000 ($36 - $41)	$50,000-$57,000 ($25-$29)	$6,300-$7,200 ($3.20-$3.60)
2010 - 2011	11.6 to 13.2	150	240	2,000	$77,000-$88,000 ($39-$44)	$48,000-$55,000 ($24-$28)	$5,800-$6,600 ($2.90-$3.30)

* Total industry fuel cost of $10.3 million ($11.2 in 2010), and annualized capital cost of 0.4 to 2 million. Annualized capital costs based on a range in retrofit costs per vessel of $100,000-$500,000 for 17 vessels reported in the ARB Ship Survey, a five year life, and 5% discount rate. Emission reductions estimated using the proportion of heavy fuel oil consumption by cruise ships compared to all vessels (~37%) and applying this ratio to total emission reductions from the proposed regulation.

L. Analysis of Alternatives

In this section, we compare the cost-effectiveness of the proposed regulation to two of the four alternative control options discuss in Chapter V. We do not discuss the cost-effectiveness of two additional alternatives discussed in Chapter V because ("Do Nothing" and "Rely on U.S. EPA and IMO Regulations") because there are no added costs associated with them.

As described below, the two alternatives analyzed would achieve significantly less emission reductions and associated health benefits. However, the cost of these alternatives would also be lower, resulting in similar cost-effectiveness to the proposal.

Alternative 1: Use Marine Gas Oil at Dockside Only

Under this alternative, ocean-going vessels visiting California ports would only be required to use marine distillate fuels at dockside. The emission reductions under this proposed alternative would be reduced by a minimum of 40 percent compared to the proposed regulation because the emissions from auxiliary engines on vessels at sea within the 24 nm boundary during transit would no longer be controlled. The actual reduction in emission reductions would be greater if auxiliary engines are allowed to transition from one fuel to another at dockside, since such transitions can take an hour or more. The recurring fuel costs associated with the proposed regulation would be reduced proportionally with the reduction in emissions.

The impact of this alternative on modification costs is difficult to estimate. There will probably be some reduction in retrofit costs, particularly with the diesel-electric vessels that would benefit most from this alternative. For example, such vessels may not need an additional tank for storing higher quantities of distillate fuel if the fuel will only be used at dockside. However, given the variabilities involved, we cannot quantify with certainty the reduction in retrofit costs under this alternative. Nevertheless, looking at the overall industry costs, the retrofit costs are relatively small compared to the recurring added fuel costs. Therefore, the overall cost-effectiveness of the alternative is expected to be similar to the proposed regulation.

Alternative 2: Diesel-Electric Vessels

Under this alternative, diesel electric vessels would have three compliance options: (1) use distillate fuels only at dockside as in Alternative 3 above; (2) use 1.5% sulfur heavy fuel oil within the 24 nautical mile boundary and at dockside; or (3) retrofit vessels to use shoreside electrical power and connect at California terminals where the facilities are available.

Under the first option, the same situation applies as in Alternative 3, except that the option only applies to diesel-electric vessels (primarily cruise vessels). This option

would achieve significantly less emission reductions and the cost would be reduced proportionately. The cost-effectiveness is expected to be similar to the staff's proposal.

For the option to use 1.5 percent sulfur heavy fuel oil, the estimated PM emission reductions are expected to be significantly less (about 18 percent versus 75 percent for staff's proposal). SOx emissions would be reduced by about 44 percent versus 80 percent for staff's proposal, and there would be no NOx reductions. On the other hand, the cost of the 1.5 percent sulfur heavy fuel is currently much less than marine gas oil. As a result, the cost of this option would be considerably less than the cost associated with staff's proposal. Overall, we expect that the PM cost-efffectiveness of this option would be in the same range as the proposed regulation.

The third option, utilizing cold ironing where available is difficult to analyze because vessels modified for cold ironing would only plug into shoreside power if it is available. To date, only a few California port terminals have shoreside power facilities installed. Additional facilities are anticipated at the Ports of Los Angeles, Long Beach and Oakland. However, it will be several years before new additional shoreside power facilities are operational. As a result, we cannot quantify the emissions reductions for this option at this time.

Overall, the emission reductions from any of these options under this alternative would be significantly less than the ARB staff proposal, although the cost-effectiveness would be similar.

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